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M 118.01: Mathematics for Music Enthusiasts

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UNIVERSITY OF MONTANA

Department of Mathematical Sciences

M 118
Math for Music Enthusiasts

Course: M 118 Sec. 01 (CRN 34073) 3 cr., Spring 2019
Mathematics for Music Enthusiasts
TΘ 11:00am–12:20pm in MATH 312

Instructor: Mark Kayll **Econtact:** mark.kayll@umontana.edu
hs.umt.edu/math/people/default.php?s=Kayll

Office: MATH 209 **Hours:** T 1:30–2:20pm, Th 12:20–1:10pm & by appointment
406.243.2403 (*tentative*) (open for all course matters, including DSS accomm.)

Prerequisites: either: M 090 (Introductory Algebra) with a minimum B− grade;
or: M 095 (Intermediate Algebra); or: ALEKS placement score ≥ 3;
and: elementary music background, plus an open mind.

Text: *The Math Behind the Music*, L. Harkleroad, Cambridge Univ. Press, 2006 [978-0-521-00935-5]

Material: Three separate units, based on: Numbers & Music; Mathematics & Music; Logarithms & Music. We'll use portions of the text as well as handouts.

Important Dates:

last day to add w/o override	Friday, 18 January (5pm);
Martin Luther King, Jr. Day holiday	Monday, 21 January (5pm);
last day to drop by Cyberbear, or select Audit grade option	Thursday, 31 January (5pm);
Presidents' Day holiday	Monday, 18 February;
last day to add/drop by Workflow	Friday, 15 March (5pm);
spring break	25–29 March;
last day to add/drop through Dean	Friday, 26 April (5pm);
last class meeting (during finals)	Thursday, 2 May 8:00–10:00am.

Description: Course topics revolve around the interplay and connections between mathematics and music. Here are some example questions to be considered: Why are there circles of fifths and fourths but not thirds or tritones?; What is equal temperament?; How is the chromatic scale related to modular arithmetic?; How is the musical staff like a logarithmic scale for pitch?; How are overtones related to the integers?; How does harmony derive from the overtone series?; What are the mathematical relationships between pitches in consonant intervals and chords?; What are the historical obstacles (going back to the Greeks) to tuning a musical scale that gives a mathematically precise harmony in all keys?

If any of these questions intrigue you, and you are looking to satisfy your general education mathematical literacy requirement, then this is the course for you.

Key musical and mathematical concepts will be introduced/reviewed as they are encountered.

Abbreviated learning outcomes: The 'official' outcomes below are reflected in the description above; see the instructor for the full (unabbreviated) list.

1. Understand the elementary number theory governing the possibilities for musical circles (of fourths, fifths, etc.).
2. Learn the relationship between the overtone series in music and the set of positive integers; understand how this impacts the mathematical relationships between pitches in consonant intervals and chords.
3. Understand mathematics underlying musical tuning systems, particularly Pythagorean tuning and equal temperament (but not necessarily limited to these two systems). Gain facility in computing frequency ratios between musical intervals in different tuning systems; be able to compare and contrast tuning systems mathematically. Become familiar, mathematically, with the Pythagorean comma, and gain awareness of other musical commas.
4. Learn the mathematics behind the placement of frets on a fretted instrument. Apply this knowledge toward the solution of problems in luthier design.
5. Gain an elementary understanding of the mathematics governing the music compositional transformations of transposition (T), inversion (I), and regression (retrograde) (R).
6. Learn how to convert between frequency ratios (of musical intervals) and semitones or cents (as two common measures of musical differences). Learn the three basic laws of logarithms. Apply these laws to solve equations involving exponentials and logarithms. Express the reason why musical intervals are additive in terms of the addition law of logarithms.

(over)

Class attendance & activities: Attendance is taken and contributes to the "in-class work" portion of the grade. Class activities include: discussion, group work, and lectures. Often group work consists of worksheets which also contribute to the "in-class work". Participation is necessary; learning mathematics is similar to learning to play a musical instrument or a new sport: one learns by *doing*, not by watching.

Readings: *Reading the text and handouts is essential for this course.* Short, possibly unannounced, quizzes based on the readings will be given.

Homework: Problems are assigned based on the in-class work, and homework problems are discussed regularly in class. Assignments are collected and checked, but individual problems are not normally graded. Homework is submitted electronically on `gradescope.com`, either in PDF or JPG format from your device. The course number is **35801**, with Entry Code **9ZW2WE**. You'll receive an email invite at your official UM email address; follow the instructions to link to `Gradescope` and get started. Solution keys are distributed in class after homework is due. *Keep in mind that the only way to learn mathematics is to do mathematics.* This means that students should be prepared to spend some quality time outside of class on this course.

I urge you to acquire the habit of staying on schedule with your reading and homework. This helps to maximize the material you're able to absorb in class, meaning less effort preparing for tests.

Assessment: Grades are based on homework assignments, in-class work, and three term tests. Traditional letter grades are assigned using the +/− system (see *UM catalog* at `catalog.umt.edu/academics/policies-procedures/`). UM's policy on Incomplete grades is followed (see *UM catalog*).

***Tentative* grading schedule:**

Item	Date(s)	Weight
Homework	10 January — 25 April	20%
In-class work	10 January — 25 April	20%
Test # 1	Thursday, 14 February ♡	20%
Test # 2	Thursday, 4 April	20%
Test # 3	Thursday, 2 May	20%

Accommodation: The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you have a disability that adversely affects your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or 406.243.2243. The instructor will work with you and Disability Services to provide an appropriate modification.

General Remarks

On credit: If you're taking this course as a general education requirement, you must choose 'traditional letter grade', not CR/NCR. A 'D−' grade is considered passing, will earn course credit, but will *not* fulfill the Gen Ed requirement. A minimum grade of 'C−' is needed to fulfill the Gen Ed math literacy requirement.

On homework: You may work with others on homework problems, and you are encouraged to do so; however, **Solutions should be written down privately in your own words.**

On tests: Each test is based on the material from the corresponding unit (i.e. no cumulative tests).

On make-ups: Make-ups for tests are *not* given unless there is a valid excuse cleared with the instructor *prior* to the test. At least one of your most detrimental homework/in-class work scores will be dropped; thus, there are no make-ups for quizzes, homework, or class work.

On deadlines: Any stated deadlines are firm; please don't ask for extensions.

On electronic devices: Cell phones must be silenced during class meetings and visits to my office. Use of a cell phone during a test for any purpose other than as a calculator is grounds for earning a zero score on that test.

On conduct: All students need to be familiar with the Student Conduct Code; it can be found in the 'A to Z Index' on the UM home page. All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the university.